CLAIMS

We claim:

1. A fuel cell system, comprising:

at least first and second fuel cells, each of the fuel cells having at least one reactant inlet line and at least one output outlet; and

a first heater arrangement operably connected to the at least one output outlet of the first fuel cell and associated with the at least one reactant inlet line of the second fuel cell such that heat from the first heater arrangement is transferred to reactants in the at least one reactant inlet line of the second fuel cell.

2. A fuel cell system as claimed in claim 1, wherein the first and second fuel cells are substantially identical.

3. A fuel cell system as claimed in claim 1, wherein

the at least one reactant inlet line comprises a fuel inlet line and an oxidant inlet line;

the at least one output outlet comprises an anode output outlet and a cathode output outlet; and

the first heater arrangement comprises a first fuel heater associated with the fuel inlet line of the second fuel cell and a first oxidant heater associated with the oxidant inlet line of the second fuel cell.

4. A fuel cell system as claimed in claim 1, wherein the first heater arrangement includes an output outlet, the fuel cell system further comprising:

a third fuel cell having at least one reactant inlet line and at least one output outlet; and

a second heater arrangement operably connected to the at least one output outlet of the second fuel cell and to the output outlet of the first heater arrangement, and associated with the at least one reactant inlet line of the third fuel cell such that heat from the second heater arrangement is transferred to reactants in the at least one reactant inlet line of the third fuel cell.

5. A fuel cell system as claimed in claim 1, further comprising:

an inlet valve arrangement associated with the at least one reactant inlet line of the second fuel cell and located downstream from the first heater arrangement.

6. A fuel cell system as claimed in claim 5, wherein

the at least one reactant inlet line of the second fuel cell comprises a fuel inlet line and an oxidant inlet line;

the first heater arrangement comprises a first fuel heater associated with the fuel inlet line of the second fuel cell and a first oxidant heater associated with the oxidant inlet line of the second fuel cell; and

the inlet valve arrangement comprises a fuel inlet valve located downstream from the first fuel heater and an oxidant inlet valve located downstream from the first oxidant heater.

7. A fuel cell system as claimed in claim 6, further comprising:

a fuel isolation valve associated with the first fuel inlet line and located upstream from the first fuel heater and an oxidant isolation valve associated with the first oxidant inlet line and located downstream from the first oxidant heater.

8. A fuel cell system, comprising:

at least first and second individually operable fuel cells that consume reactants and produce power and output;

means for heating the reactants to be consumed by the second fuel cell with the output from the first fuel cell; and

means for sequentially activating the fuel cells.

9. A fuel cell system as claimed in claim 8, wherein the means for heating the reactants to be consumed by the second fuel cell with the output from the first fuel cell heats the reactants to be consumed by the second fuel cell at a location upstream from the second fuel cell.

10. A fuel cell system as claimed in claim 8, wherein the means for sequentially activating the fuel cells comprises means for activating the first fuel cell prior to the second fuel cell and activating the second fuel cell after the output from the first fuel cell has heated the reactants to be consumed by the second fuel cell to a predetermined temperature.

11. A fuel cell system as claimed in claim 10, further comprising:

a third individually operable fuel cell that consumes reactants and produces power and output; and

means for heating the reactants to be consumed by the third fuel cell with the output from at least the second fuel cell;

wherein the means for sequentially activating the fuel cells comprises means for activating the first fuel cell prior to the second fuel cell, activating the second fuel cell prior to the third fuel cell, and activating the third fuel cell after the output from the at least the second fuel cell has heated reactants to be consumed by the third fuel cell to a predetermined temperature.

12. A fuel cell system as claimed in claim 11, further comprising:

means for monitoring a load on the fuel cell system and preventing actuation of the third fuel cell until the load reaches a predetermined level.

13. A method of operating a fuel cell system including at least first and second fuel cells that consume reactants and produce power and output, the method comprising the steps of:

activating the first fuel cell without activating the second fuel cell;

heating reactants to be consumed by the second fuel cell with the output from the first fuel cell; and

activating the second fuel cell after the reactants to be consumed by the second fuel cell have been heated to a predetermined temperature.

14. A method as claimed in claim 13, wherein the step of activating the first fuel cell without activating the second fuel cell comprises supplying reactants to the first fuel cell without supplying reactants to the second fuel cell.

15. A method as claimed in claim 13, wherein the step of heating reactants to be consumed by the second fuel cell with the output from the first fuel cell comprises supplying the output from the first fuel cell to a heater and heating the reactants to be consumed by the second fuel cell with the heater.

16. A method as claimed in claim 13, wherein the step of heating reactants to be consumed by the second fuel cell with the output from the first fuel cell comprises isolating a quantity of reactants from other reactants and heating the isolated quantity of reactants with the output from the first fuel cell.

17. A method as claimed in claim 13, wherein the step of activating the second fuel cell comprises supplying the reactants to be consumed by the second fuel cell to the second fuel cell after the reactants have been heated to a predetermined level.

18. A method as claimed in claim 13, further comprising the step of:

determining whether a load has be placed on the fuel cell system;

wherein the step of activating the second fuel cell comprises activating the second fuel cell after the reactants to be consumed by the second fuel cell have been heated to a predetermined level and it has been determined that a load has been placed on the system.

19. A method as claimed in claim 18, wherein

the fuel cell system includes at least first, second and third fuel cells; and

the step of activating the first fuel cell comprises activating the first fuel cell without activating the second and third fuel cells.

20. A method as claimed in claim 19, wherein the step of activating the second fuel cell further comprises activating the second fuel cell without activating the third fuel cell.

21. A method as claimed in claim 20, further comprising the step of:

heating reactants to be consumed by the third fuel cell with the output from the second fuel cell.

22. A method as claimed in claim 21, further comprising the step of:

monitoring the load placed on the fuel cell system;

activating the third fuel cell in response the monitored load reaching a predetermined level.

23. A method as claimed in claim 22, further comprising the step of:

deactivating the third fuel cell in response the monitored load dropping below a predetermined level.

24. A system, comprising:

a power consuming apparatus; and

a fuel cell system having a pilot unit and a plurality of power units operably connected to the power consuming apparatus, the fuel cell system being operable in

(1) a standby state where the power units are not activated, the pilot unit is activated, and output from pilot unit heats reactants to be consumed by at least one of the power units, and

(2) a power supply state where at least one of the power units supplies power to the power consuming apparatus and output from the at least one power unit heats reactants to be consumed by at least one other power unit.

25. A system as claimed in claim 24, further comprising:

a reactant supply operably connected to the pilot unit and power units; and

a plurality of reactant valves respectively located between the reactant supply and the pilot and power units.

26. A system as claimed in claim 25, wherein the pilot unit includes a pilot unit fuel cell and the power units comprise respective power unit fuel cells, the system further comprising:

a controller, operably connected to the reactant valves, adapted to control the reactant valves to allow reactant flow to the pilot unit and to block reactant flow to the power units when the system is in the standby state.

27. A system as claimed in claim 26, wherein the controller is adapted to control the reactant valves to sequentially permit reactant flow to the power unit fuel cells when the system is in the power supply state.

28. A system as claimed in claim 26, wherein

the plurality of power units comprises at least first and second power units and the controller is adapted to permit reactant flow to the first power unit fuel cell and block reactant flow to the second power unit fuel cell when the system is initially placed in the power supply state; and

output from the first power unit fuel cell heats reactants to be consumed by the second power unit.

29. A system as claimed in claim 28, wherein controller is adapted to permit reactant flow to the second power unit fuel cell after the reactants to be consumed by the second power unit reach a predetermined temperature.

30. A system as claimed in claim 28, wherein controller is adapted to permit reactant flow to the second power unit fuel cell after the reactants to be consumed by the second power unit reach a predetermined temperature and a load imparted by the power consuming apparatus reaches a predetermined level.